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Original Paper

Health-Related Quality of Life Predicts Mortality in Older but Not Younger Patients Following Cardiac Surgery

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The investigators assessed preoperative health-related quality of life as a predictor of 6-month mortality after cardiac surgery in older (65 years of age and older) vs. younger patients. Multivariable regression, stratified by age groups, was used to compare the association between preoperative Physical Component Summary and Mental Component Summary scores from the Short Form-36 health status survey and mortality. In multivariable analyses of older patients, lower preoperative Physical Component Summary (odds ratio, 1.54; 95% confidence interval, 1.19–2.00; p=0.01) and Mental Component Summary (odds ratio, 1.26; 95% confidence interval, 1.06–1.49; p=0.03) scores were independently associated with mortality. In contrast, neither Physical Component Summary (p=0.82) nor Mental Component Summary (p=0.79) scores were associated with mortality in the younger subgroup. This study demonstrated that preoperative health status is an independent predictor of mortality following cardiac surgery in older but not younger patients. Preoperative patient self-report of health status may be particularly useful in refining risk stratification and informing decision-making before and following cardiac surgery in older patients. (AJGC. 2005;14:176–182) ©2005 Le Jacq Ltd.

The older population (aged 65 years and older) constitutes the most rapidly growing segment of the population with cardiovascular disease.[1] The number of older patients undergoing cardiac surgery has increased dramatically over the last 20 years and accounts for more than 50% of the patients requiring cardiac surgery, a proportion likely to grow as the population ages.[2,3] Older patients requiring cardiac surgery have more severe coronary artery disease (CAD), depressed left ventricular systolic function, and a larger burden of comorbidity.[2] Accordingly, operative mortality for coronary artery bypass graft (CABG) and/or valve replacement surgery increases markedly with age.[2]

Health-related quality of life (HRQL) has been shown to predict mortality for patients with various medical conditions, including CAD.[4–6] In patients undergoing CABG surgery, preoperative HRQL has been associated with in-hospital and 6-month mortality independent of the clinical risk factors.[7,8] HRQL may be of particular importance to older patients undergoing cardiac surgery, given their burden of comorbid medical conditions and the variability of the aging process. To date, however, HRQL has not been specifically evaluated as a predictor of mortality in older patients undergoing cardiac surgery.

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The objective of our study was to determine whether preoperative HRQL was predictive of mortality in older vs. younger patients following cardiac surgery. We hypothesized that HRQL would predict 6-month mortality in older but not younger patients.

METHODS

Subjects. Patients were enrolled in the Department of Veterans Affairs (VA) Cooperative Study in Health Services #5, "Processes, Structures, and Outcomes of Care in Cardiac Surgery" (PSOCS), a multicenter, prospective, observational study investigating the linkages between processes and structures of care and risk-adjusted outcomes. Details of the PSOCS study have been published previously.[9] Seven hundred thirty-four variables representing patient-related risk factors, processes, structures, and outcomes of care were collected for a sample of 4969 patients undergoing cardiac surgery at 14 VA medical centers representative of the spectrum of center-specific risk-adjusted operative mortality between September 1992 and December 1996. Data were collected prospectively by full-time, trained research nurses located at each of the 14 sites. Risk data were obtained by patient interview and chart review within 72 hours before surgery. The baseline Short Form-36 (SF-36) health status survey was given to patients for self-administration. A research nurse attempted to complete the survey by means of a personal interview for patients unable to complete the written survey.

The patients included in the current study were all those enrolled in the PSOCS who underwent surgery (CABG only, CABG and valve replacement, or valve replacement only) and completed a preoperative SF-36. Of the 4969 patients enrolled, 3160 (63.6%) completed a baseline SF-36. The primary reason for missing the baseline SF-36 was urgent/emergent surgical priority. Therefore, the study population included predominantly elective patients. Patients not completing the SF-36 were more likely to have Canadian Cardiovascular Society angina functional class III or IV, recent myocardial infarction, left main and/or three-vessel CAD, reduced left ventricular systolic function, and to require preoperative IV nitroglycerin or intra-aortic balloon pump. In addition, these patients had a higher frequency of cerebrovascular disease, hypertension, and chronic obstructive pulmonary disease.

Predictor Variables. The primary predictor variables of interest were the Physical Component Summary (PCS) and Mental Component Summary (MCS) scores from the preoperative SF-36.[10] The summary scores have been standardized to the general US population (mean score=50 and SD=10), allowing norm-based interpretation. Very high PCS scores indicate no physical limitations, disabilities, or decrements in well-being as well as high energy level.[11] Very low scores indicate substantial limitations in self-care, physical, social, and role activities; severe bodily pain; or frequent tiredness. Very high MCS scores indicate frequent positive affect and absence of psychological distress and limitations in usual social/role activities due to emotional problems. Very low scores indicate frequent psychological distress and substantial social and role disability due to emotional problems. Scoring for the PCS and MCS summary scores followed the methods described by Ware et al.[12]

Candidate preoperative clinical variables for risk adjustment were derived from the published literature on clinical risk variables for mortality following cardiac surgery in both VA and non-VA populations.[13–17] These variables are listed in Table I.

Outcome Variable. The dependent, or outcome, variable was all-cause 6-month mortality following cardiac surgery. Vital status was determined by the research nurses and confirmed using the Department of Veterans Affairs Beneficiary Identification and Record Locator System. This method is comparable to the National Death Index for mortality assessment and is considered extremely reliable in VA populations.[18] Follow-up was complete for all patients.

Statistical Analyses. There have been numerous studies in the cardiovascular as well as general medical literature that have used age 65 years or older to define older patients. Given this precedent in the literature and because the mean age of our study population was 64 years, we used age 65 years or older to define the older population in our primary analysis. Acknowledging that this is somewhat arbitrary, we performed secondary analyses using alternative age group cut-offs.

Baseline characteristics of older patients (65 years or older) were compared with younger patients (younger than 65 years) using the chi-square test for categoric variables and the t test for continuous variables. Six-month mortality rates were stratified by both age group and quartiles of baseline PCS or MCS scores to assess the relationship between baseline HRQL and mortality. A chi-square test was performed to evaluate trends in this association.

Table I. Baseline Characteristics of the Study Population

Preoperative Clinical Risk Variables	Age ≥65 yr (N=1543)	Age <65 yr (N=1617)	P Value
Male (%)	98.2	98.8	0.23
Prior heart surgery (%)	11.5	11.1	0.68
Diabetes (%)	29.0	26.2	0.08
Cerebrovascular disease (%)	22.4	12.4	<0.01
Peripheral vascular disease (%)	30.9	22.9	<0.01
Current smoker (%)	12.9	35.2	<0.01
Hypertension (%)	61.0	53.1	<0.01
Chronic obstructive pulmonary disease (%)	15.8	10.5	<0.01
Serum creatinine (mg/dL) (mean [SD])	1.4 (0.8)	1.2 (0.8)	<0.01
New York Heart Association functional class III or IV (%)	40.4	39.6	0.62
Canadian Cardiovascular Society angina class III or IV (%)	55.5	61.3	<0.01
Myocardial infarction within 7 days (%)	2.2	2.2	0.94
Surgical priority: urgent or emergent (%)	9.9	9.8	0.94
IV nitroglycerin (%)	10.3	8.9	0.18
Intra-aortic balloon pump (%)	0.6	1.0	0.29
Left ventricular ejection fraction <0.45 (%)	33.2	35.2	0.23
Left main coronary artery disease (%)	20.0	18.6	0.32
Three-vessel coronary artery disease (%)	39.3	35.9	0.05
Physical Component Summary score (mean [SD])	32.5 (9.2)	32.7 (9.0)	0.60
Mental Component Summary score (mean [SD])	44.9 (11.8)	42.8 (12.0)	<0.01

Multivariable logistic regression models were constructed to evaluate the association between preoperative HRQL and mortality following cardiac surgery. In our first model, the entire study population was included to determine if preoperative PCS and MCS scores were independently associated with 6-month mortality after adjusting for traditional clinical risk variables. Next, the study population was stratified by age group (65 or older vs. younger than 65), and separate multivariable models were constructed to assess for differences in the association between PCS and MCS scores and mortality in these subgroups.

Models were built by applying backward regression ($p<0.10$ to enter and $p<0.05$ to remain in the model) to the variables listed in Table I. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for each independent variable in the multivariate models. Because the magnitude of the OR for continuous variables depends on the increment of the variable, we chose increments of one SD for continuous variables to standardize comparisons.

To assess the robustness of our data, we performed sensitivity analysis using different age cut-offs (70 or older and 75 or older) and surgical subgroups (CABG-only surgery and valve surgery with or without concomitant bypass) to determine if preoperative health status remained predictive of mortality. Regression models were constructed in a fashion similar to that of the primary risk models. The study was approved by the Colorado Multiple Institutional Review Board. All analyses were performed using the SAS statistical package version 8.0 (SAS Institute, Inc., Cary, NC).[19]

RESULTS

Baseline characteristics of the study population are listed in Table I. Overall, patients aged 65 years or older comprised almost half of the study population (48.8%). Older patients had a higher burden of comorbidities and were more likely to have three-vessel CAD compared with younger patients. The preoperative mean PCS scores were similar (32.5±9.2 vs. 32.7±9.0; $p=0.60$) in both age groups, but older patients had higher mean MCS scores (44.9±11.8 vs. 42.8±12.0; $p<0.01$).

The overall unadjusted 6-month mortality rate was 5.6% for the entire cohort. The mortality rate was 7.8% among older patients vs. 3.5% among younger patients ($p<0.01$). In the 65-or-older group, the mortality rate increased by two-fold from the highest quartile of baseline PCS score to the lowest quartile (Figure 1A; $p<0.01$ for trend). Similarly, the mortality rate increased by four-fold from the highest quartile of baseline MCS score to the lowest quartile for older patients (Figure 1B; $p=0.02$ for trend).

In the entire patient cohort, both PCS and MCS scores were significant predictors of 6-month mortality after adjustment for traditional clinical variables (Table II). A 10-point (1 SD) decrement in the baseline PCS score had an OR of 1.30 (95% CI, 1.06–1.59; $p=0.01$) and a 10-point decrement in the baseline MCS score had an OR of 1.16 (95% CI, 1.01–1.33; $p=0.03$). Other statistically significant predictor variables in the multivariable risk model included preoperative intra-aortic balloon pump use, prior heart surgery, chronic obstructive pulmonary disease, increasing age, urgent or emergent surgical priority, hypertension, diabetes, New York Heart Association function class III or IV, left ventricular ejection fraction <0.45, and elevated serum creatinine.

In models stratified by age, both PCS (OR, 1.51; 95% CI, 1.17–1.96; $p<0.01$) and MCS (OR, 1.28; 95% CI, 1.08–1.53; $p<0.01$) scores remained significantly associated with 6-month mortality in older patients (Table III). In contrast, neither PCS score (OR, 0.96; 95% CI, 0.69–1.34; $p=0.82$) nor MCS score (OR, 0.97; 95% CI, 0.76–1.23; $p=0.79$) were significantly associated with 6-month mortality in younger patients (Figure 2).

The results of the sensitivity analysis using different age cut-offs and surgical subgroups were similar to the primary findings. Preoperative PCS and MCS remained predictive of mortality in the 70-or-older (PCS: OR, 1.69; MCS: OR, 1.19) and 75-or-older (PCS: OR, 1.64; MCS: OR, 1.18) subgroups. Similarly, PCS and MCS were predictive of mortality among older patients undergoing CABG-only surgery (PCS: OR, 1.70; MCS: OR, 1.17) and valve surgery with or without concomitant bypass (PCS: OR, 1.71; MCS: OR, 1.21).

DISCUSSION

The objective of this study was to determine if preoperative HRQL was predictive of mortality following cardiac surgery in older patients compared with younger patients. In patients 65 or older, we found that preoperative physical health status was an independent predictor of 6-month mortality, with a 51% relative increased risk for mortality for every 10-point (approximately 1 SD) decrement in the baseline PCS score. Similarly, preoperative mental health status was also an independent predictor of 6-month mortality, with a 28% relative increased risk for mortality for every 10-point (approximately 1 SD) decrement in the baseline MCS score. In contrast, preoperative physical and mental health status were not associated with mortality in patients younger than 65 years of age.
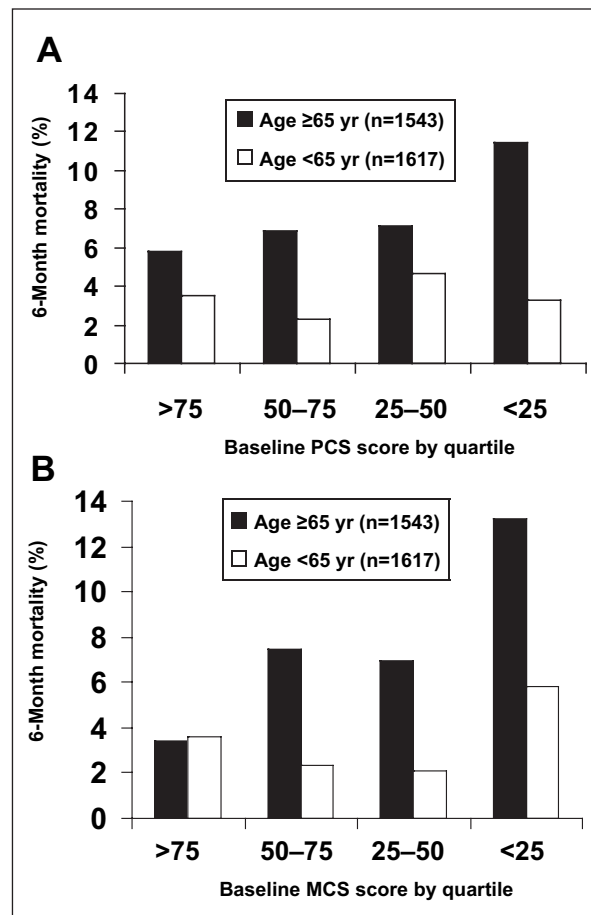

Figure 1. A) Mortality by quartile of the baseline Physical Component Summary (PCS) scores; B) mortality by quartile of the baseline Mental Component Summary (MCS) scores

This study expands the previous literature on HRQL and mortality in cardiac surgery. Prior studies on quality of life as a predictor of mortality following cardiac surgery have demonstrated that worse physical health status is associated with increased lengths of hospital stay and higher in-hospital and 6-month mortality.[7,8] On the other hand, the association between preoperative mental health status and mortality has been inconsistent. Previous studies, however, did not specifically focus on older patients, who often have a higher burden of comorbid medical conditions, and therefore it was unknown whether preoperative HRQL assessment would add incremental prognostic information to the clinical risk profile. In the present study, we found that both physical and mental health status were significantly associated with 6-month mortality, and that this relationship was confined to those 65 years of age or older.

The results of this study are also consistent with previous literature on the association between

Table II. Predictors of 6-Month Mortality in the Multivariate Model for the Entire Cohort

VARIABLE	ODDS RATIO	95% CONFIDENCE INTERVAL	P VALUE
Intra-aortic balloon pump	3.69	1.35–10.1	0.01
Prior heart surgery	2.48	1.69–3.64	<0.01
Chronic obstructive pulmonary disease	1.80	1.23–2.64	<0.01
Age, per 10-year increment	1.77	1.44–2.17	<0.01
Surgical priority: urgent or emergent	1.74	1.11–2.73	0.01
Hypertension	1.60	1.13–2.27	0.01
Diabetes	1.59	1.14–2.22	<0.01
New York Heart Association functional class III or IV	1.49	1.06–2.09	0.02
Left ventricular ejection fraction <0.45	1.48	1.07–2.04	0.02
Serum creatinine, per 0.83 mg/dL increment	1.23	1.12–1.34	<0.01
Physical Component Summary score, per 10-point lower score	1.30	1.06–1.59	0.01
Mental Component Summary score, per 10-point lower score	1.16	1.01–1.33	0.03

Table III. Predictors of 6-Month Mortality in the Multivariate Model for the Age ≥65 Group

VARIABLE	ODDS RATIO	95% CONFIDENCE INTERVAL	P VALUE
Intra-aortic balloon pump	3.48	0.80–15.12	0.10
Prior heart surgery	2.43	1.51–3.91	<0.01
Surgical priority: urgent or emergent	2.07	1.21–3.52	0.01
Chronic obstructive pulmonary disease	1.80	1.14–2.84	0.01
New York Heart Association functional class III or IV	1.60	1.06–2.44	0.03
Serum creatinine, per 0.83 mg/dL increment	1.35	1.19–1.54	<0.01
Physical Component Summary score, per 10-point lower score	1.51	1.17–1.96	<0.01
Mental Component Summary score, per 10-point lower score	1.28	1.08–1.53	<0.01

HRQL and mortality in older persons. Quality of life measures have been shown to predict mortality among older persons hospitalized on the medical service, as well as those living in the community.[20–23] The 2-year mortality rate was more than doubled among hospitalized medical patients with the highest category of functional impairment compared with those with the lowest, and a similar relationship was also demonstrated in a sample of community-dwelling older adults. Furthermore, self-rated poor health has been associated with increasing need for physician visits, home health support, and medication use.[22] The current study expands the previous literature by demonstrating that HRQL also predicts mortality in older patients following a surgical procedure. This finding, along with the prior literature, highlights the importance of HRQL measurement among older patients for enhanced risk assessment.

The specific mechanisms underlying the association between HRQL and mortality in older persons, but not younger persons, is unknown. Older persons have more comorbid conditions and worse functional status compared with younger patients.[24] Therefore, one potential explanation for the predic-tive utility of preoperative HRQL in older patients is that it may provide a synthesis of the burden of comorbid illnesses that is not easily reflected in the individual risk factors.[25] In addition, there is significant variability in the aging process, and it is often difficult to accurately quantify a patient's physiologic reserve or the frailty of an individual.[26] HRQL questionnaires like the SF-36 offer a more objective measurement of a patient's functional status compared with the clinician's bedside "eyeball test." Finally, the reason HRQL is not associated with mortality in those younger than 65 is unknown. One potential explanation is that there is less variability in the aging process in those younger than 65, and the traditional clinical risk factors more accurately reflect patient risk. Further studies are needed to better understand the reasons for these differences.

The results of this study support that HRQL measures can be incorporated into the preoperative risk profile along with the traditional clinical risk variables. Among patients with similar preoperative clinical risk profiles, lower physical and mental health status identify higher-risk older patients before the operation. Furthermore, the

health status data can be utilized to identify patients who may benefit from more aggressive postoperative care and follow-up.

Several potential limitations of this study should be addressed. First, the study population included only patients with a preoperative SF-36, conferring a bias toward more elective, lower-risk cases. However, it is often logistically difficult to obtain an SF-36 on urgent/emergent cases, and most of these patients have pressing indications for cardiac surgery. The study population may therefore reflect a realistic population in which one may consider baseline HRQL as part of the preoperative evaluation. Second, the study population was largely male, and veteran populations appear to have worse health status than nonveteran populations, both of which may limit the generalizability of our findings to non-VA settings. Third, since this study was conducted, technical and procedural changes have occurred (e.g., off-pump bypass surgery), and subsequent research is needed to confirm the associations noted in the current era of cardiac surgery. Finally, mortality after CABG surgery may be impacted by factors such as processes and structures of care, complications of the surgery, or interim life change or health events. While future studies should evaluate these variables as predictors of mortality, the focus of this study was on the preoperative evaluation to inform preoperative risk assessment and counseling of patients.

In conclusion, this study demonstrated that preoperative health status is an independent predictor of mortality following cardiac surgery in older but not younger patients. Preoperative patient self-reported health status may be particularly useful in further refining risk stratification and informing decision-making before cardiac surgery in older patients. Furthermore, preoperative health status may identify patients who could potentially benefit from more aggressive postoperative care and referral to a formal cardiac rehabilitation program.

Figure 2. Physical Component Summary (PCS) and Mental Component Summary (MCS) scores as predictors of 6-month mortality, stratified by age

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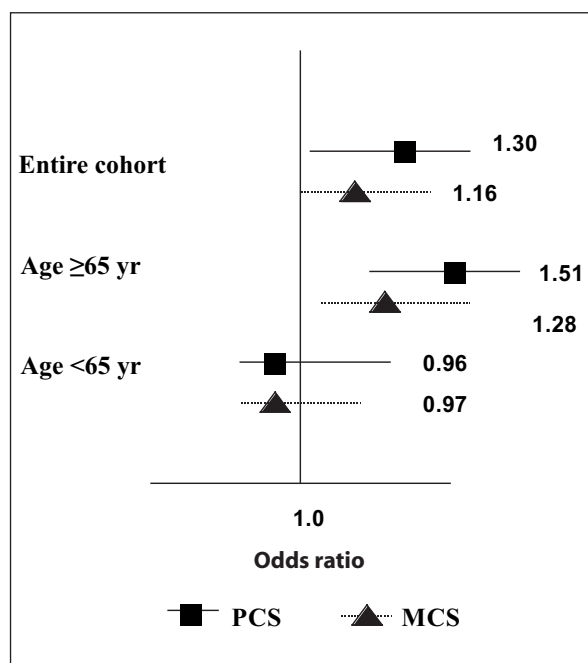
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